# Defense Science & Technology

# Smart Sensor Web

**LTC Bruce L. Gwilliam, USA, Special Projects Officer**

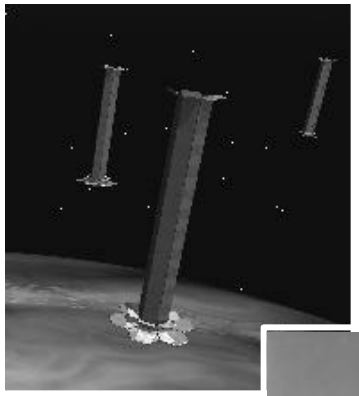
**Office of the Deputy Under Secretary of Defense (Science & Technology)**

**Presentation to NDIA, October 12, 2000**

# DoD Science &Technology Mission

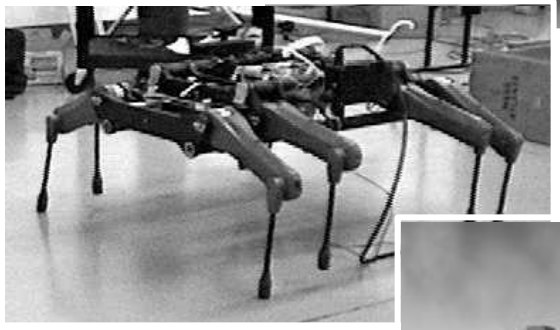
***To ensure that the warfighters today and tomorrow have superior and affordable technology to support their missions, and to give them revolutionary war-winning capabilities.***

# Future Revolutionary Capabilities



***Microsatellites***

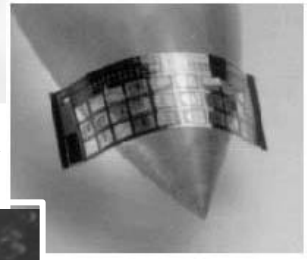
***Micro Air Vehicles***



***Micro Robots***

***DD-21***

***Joint Strike Fighter***



***Flexible Sensor Skins***

***Augmented Reality***

***Bio Sensors***

**Embedded Biofluidic Chips**

# DUSD (S&T) Priorities
(2000)

- Basic Research
- Five Focus Areas
  - Chemical & Biological Defense
  - Information Assurance
  - Hardened & Deeply Buried Targets
  - Smart Sensor Web
  - Cognitive Readiness
- Cross Cutting Initiatives
  - Software Intensive Systems
  - High Performance Computing
  - Modeling and Simulation
- Technology Transition Watch/Exposition
- S&T Pilot Laboratory Program

# Smart SensorWeb

***Complete Situation Awareness***

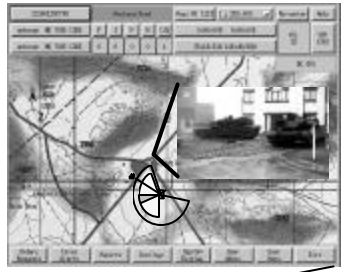
***Real-time Imagery***
***Micro-Weather***
***Moving Targets***
***Integration***

***Physical Models***
***Dynamic Data Bases***
***Micro Sensors***
***Wireless Communications***
***Next Generation Internet***

***DoD Science & Technology***

# Smart SensorWeb

***Vision:*** **An intelligent, web-centric distribution and fusion of sensor information . . . that provides greatly enhanced situational awareness, on demand, to Warfighters at lower echelons.**



**"… emphasizes large arrays of local sensors joined with other assets: imagery, weather, weapons, simulations, etc. . . ."**

- **Enhanced situational awareness**
- **On-demand intelligent information**
  - **Images, weather, weapons, etc.**
- **Available to lower echelons**
- **Rapid weapon response**

# Smart SensorWeb

Local Situational Awareness Through Netted, Processed, Low Cost Sensor Arrays

## Smart SensorWeb

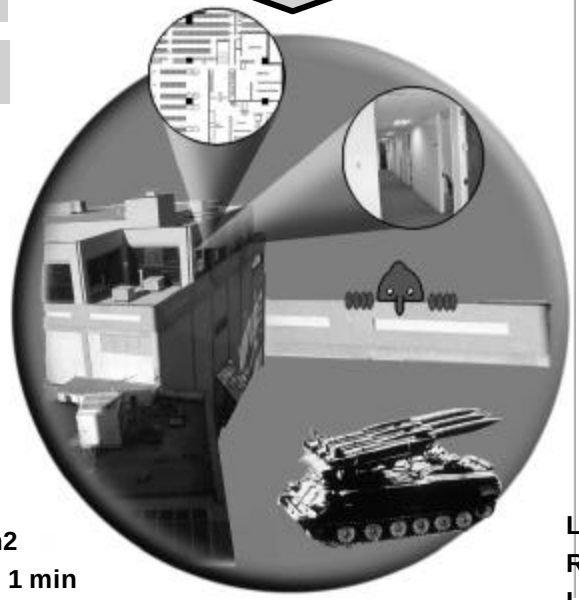
### Sensor Technologies

- TV
- Uncooled Thermal
- LADAR
- Weather
- Acoustic
- Magnetic
- COTS/MOTS

### Enablers

- MEMS
- ATR
- Computers
- Sensor Fusion Displays
- Wireless Networks
- Robotics
- GPS

**Resolution Time**



## Current ISR

### Sensor Technologies

- SAR, IFSAR
- GMTI
- HRR
- Cooled Thermal
- LADAR
- Panchromatic
- Spectral

### Enablers

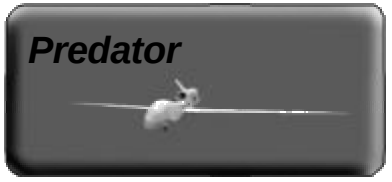
- Data Links
- ATR
- Hi Perf Comp
- UAV
- MIMC
- GPS

Small Areas £ 1km2
Response Times £ 1 min
Locations Errors £ 1 mil
Spatial Resolution £ .3 m

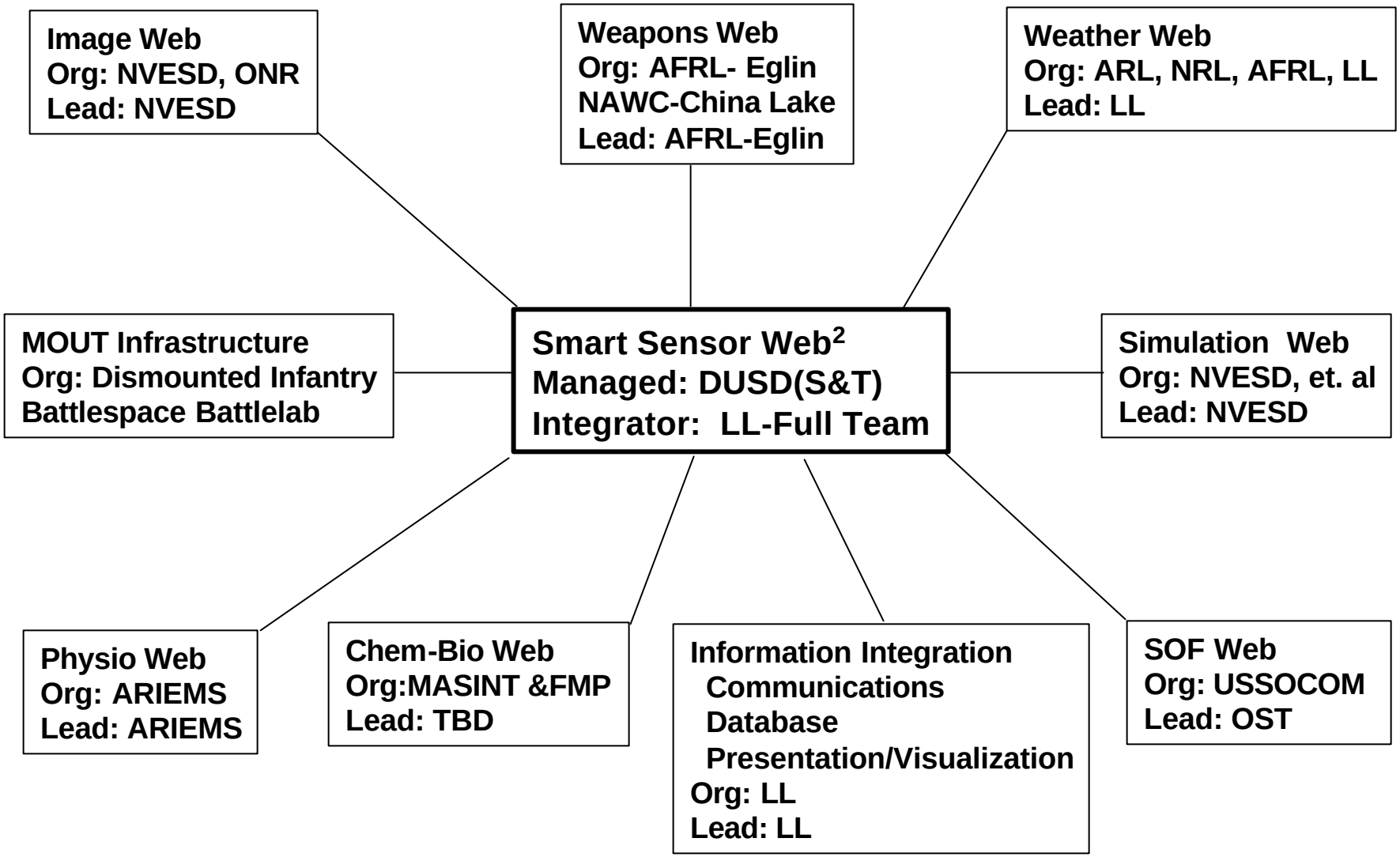
Large Areas £ 100 km2
Response Times ³ 1 min
Locations Errors ³ 1 km
Spatial Resolution .3 - 30m

### Unique SSW Capabilities

- Urban Canyons
- Subways, Sewers
- Difficult Rural Terrain
- Heavily Forested Areas
- Track Slow & Fast Objects
- Rapid Response Time



# Technical Structure



# IR Micro Camera Program

**Program Goal: $200 Camera**

- **UL3: Ultra low cost FLIR for day/night imaging:**
  - **90 Grams (including optic)**
  - **600 mW @ 3.5V**
  - **Development complete in July 00**

**Detection of Walking Man Target**

| FPA | Sensor Field of Regard/Range | |
|---|---|---|
| | 40° FOV | 15° FOV |
| 160x120 | FOR = 164m/ Range= 240m (165m) | 167m/ 640m (440m) |
| 320x240 | 328m/ 480m (330m) | 334m/ 1280m (880m) |

**Assumes Line of Sight.**
**Issue: Terrain Complexity vs. Camera Range/Cost**

**Target: Walking Man (0.75m/2.0° C)**
**50% (70%) Detection/0.75 cycles on target**
**Atmosphere: 80%/km**

# Examples of Mini-UAV Projects

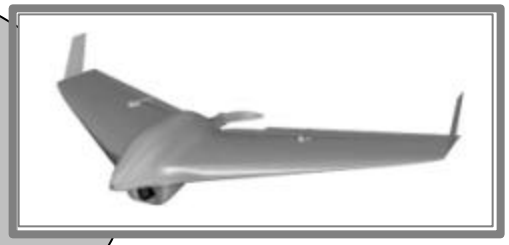
*Organic Small Unit Capability*

**Surrogate UAVs Candidates**

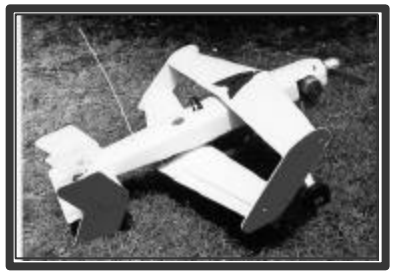
**CAMCOPTER**

- Commercial UAV
- Thermal sensor

**Para-Eyes**
**(NVESD/NRL)**



**Mini Air Vehicles**
**(DARPA)**



**Back Pack**
**(NVESD FY00 Congressional Plus Up)**

| | | | |
|---|---|---|---|
| *Wingspan* | *14.7 sq ft chute* | *36 inches* | *36 inches* |
| *Max TO Weight* | *6.5 lbs* | *2.25 lbs* | *25 lbs* |
| *Payload Weight* | *0.7 lbs* | *0.56 lbs (9 oz)* | *8 lbs* |
| *Sensor* | *120 x 160 CCD*<br>*240 x 320 (Growth)* | *CCD*<br>*240 x 320 (Growth)* | *CCD*<br>*240 x 320 (Growth)* |
| *Fuel* | *Battery* | *Battery* | *Oil/Alcohol or MOGAS* |

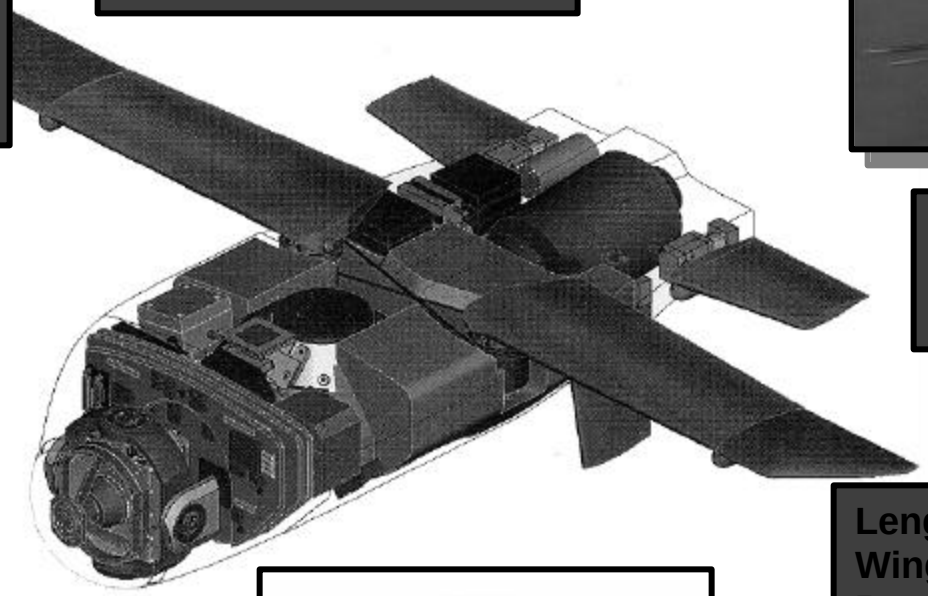
**NVESD /AATD/AMCOM MOU to Develop an Integrated Sensor w/ Mini-UAV**

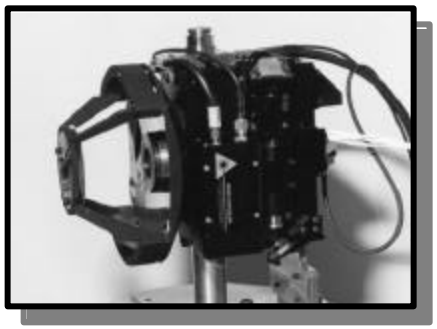
# LOCAAS Characteristics

**INS/GPS**
- Midcourse Guidance
- Flexible Search Pattern

**Guidance Integrated Safe/Arm and Fuzing**
- Optimal Fuzing Time
- Aimpoint Selection

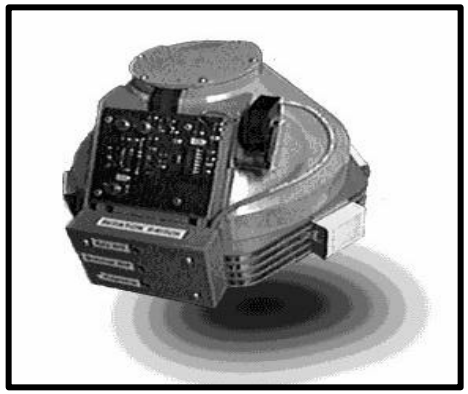
**Miniature Turbojet**
- Standoff Range
- Large Search Area





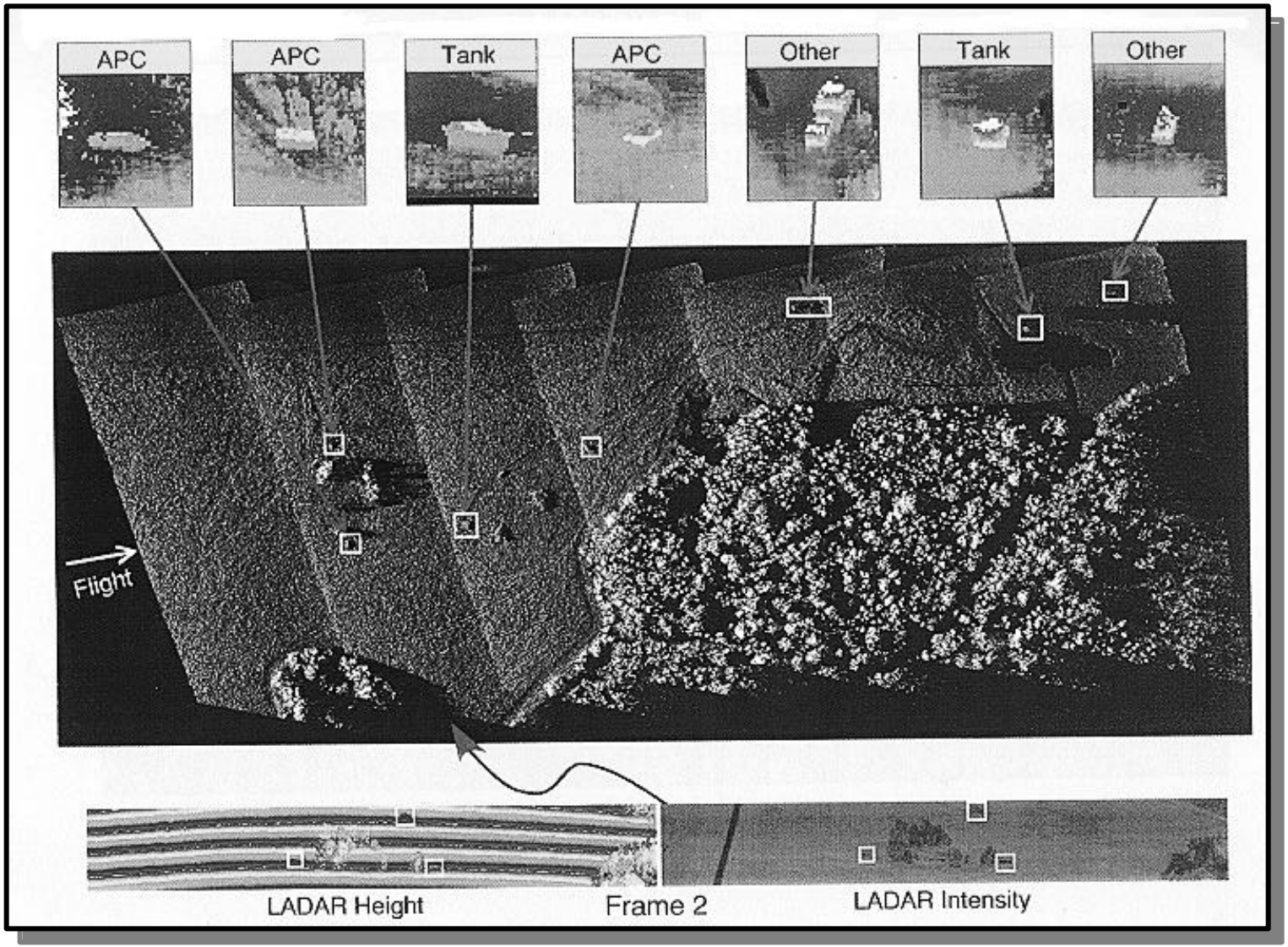
| | |
|---|---|
| Length | 31” |
| Wingspan | 47” |
| Box size | 8”x10” |
| Weight | 85-95 lbs |

**Solid State LADAR Seeker**
- Large Field of Regard
- Autonomous Target Acquisition
- Simplified Mission Planning

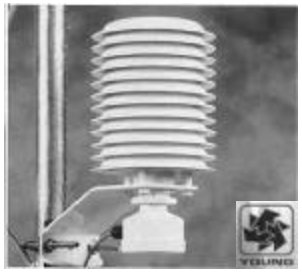


**Multi-mode Warhead**
- Optimized Lethality
- Minimize Collateral Damage

# LADAR Automatic Target Recognition Captive Flight Test Results



# Notional Weather Sensors & Data

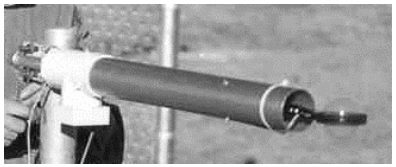


**Thermometer/ Hygrometer**

**Anemometer**

**Ceilometer**

**Visibility / Precip Type**



**Radiometer**

**Digital Camera**

## Standard Measurements (all sites):

- Temperature / Humidity
- Wind Speed and Direction

## Also at Primary Stations:

- Cloud amount and ceiling height
- Visibility
- Precipitation rate and type
- Solar radiation
- Visible camera image

## Data Rates:

- Primary sites: 1-sec sampling, 1-min avg
- Remote sites: 5-sec sampling, 5-min avg, 15-min data collection

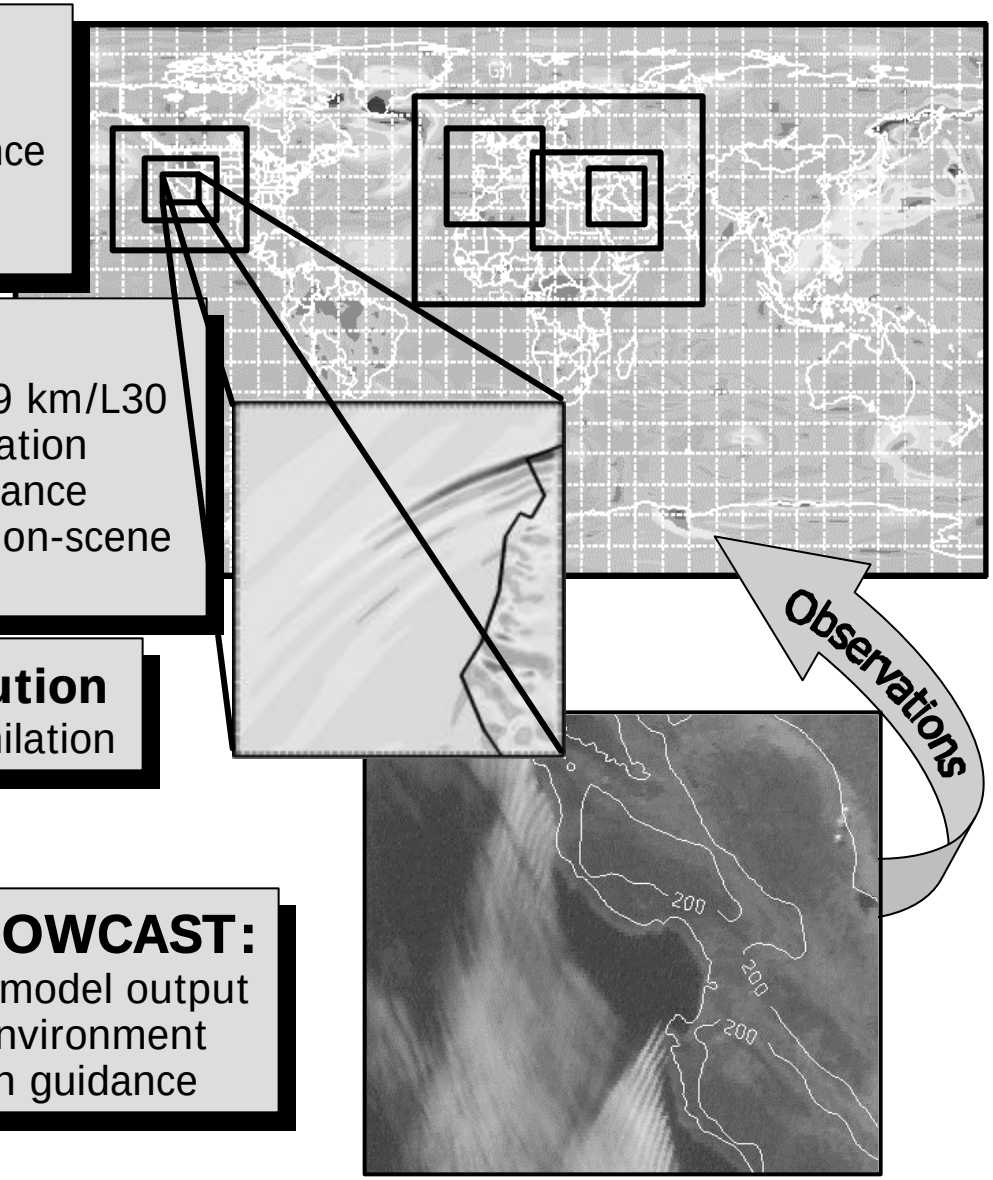
# Data Assimilation and Fusion
# Global/Mesoscale/Tactical/Nowcast

**NOGAPS:**
- FNMOC spectral model, T159/L24
- Data assimilation; 0-10 day guidance
- Provides boundary conditions for COAMPS coarse mesh

**COAMPS:**
- FNMOC nonhydrostatic model, <9 km/L30
- Globally relocatable; Data assimilation
- Explicit moist physics; 0-72h guidance
- Provides boundary conditions for on-scene COAMPS coarse mesh

**TAMS/RT: 3 km resolution**
- On-scene tactical data assimilation

**WEATHER WEB NOWCAST:**
- Fuse observations and model output
- Common battlespace environment
- Tactical end users; 0-6h guidance



An Adams Business Media Publication

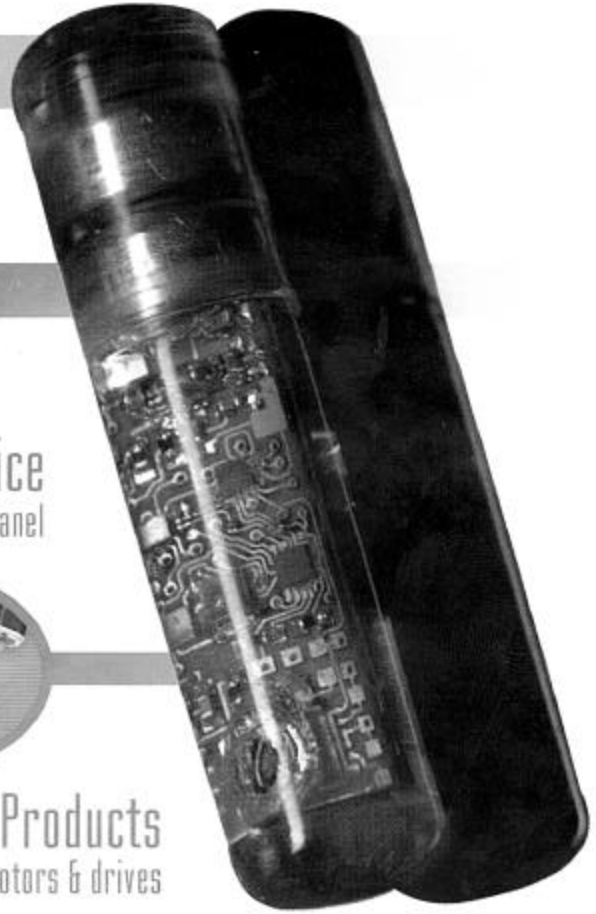
January 1999

# MEDICAL EQUIPMENT DESIGNER

DENTAL
ORTHOPEDIC
ELECTRO MEDICAL
SURGICAL/MEDICAL
IMAGING/DIAGNOSTICS

The Digest of Medical Design Engineering News
www.medicaldesigner.com

## "Pill-Sized" transmitter
to monitor at-risk pregnancies

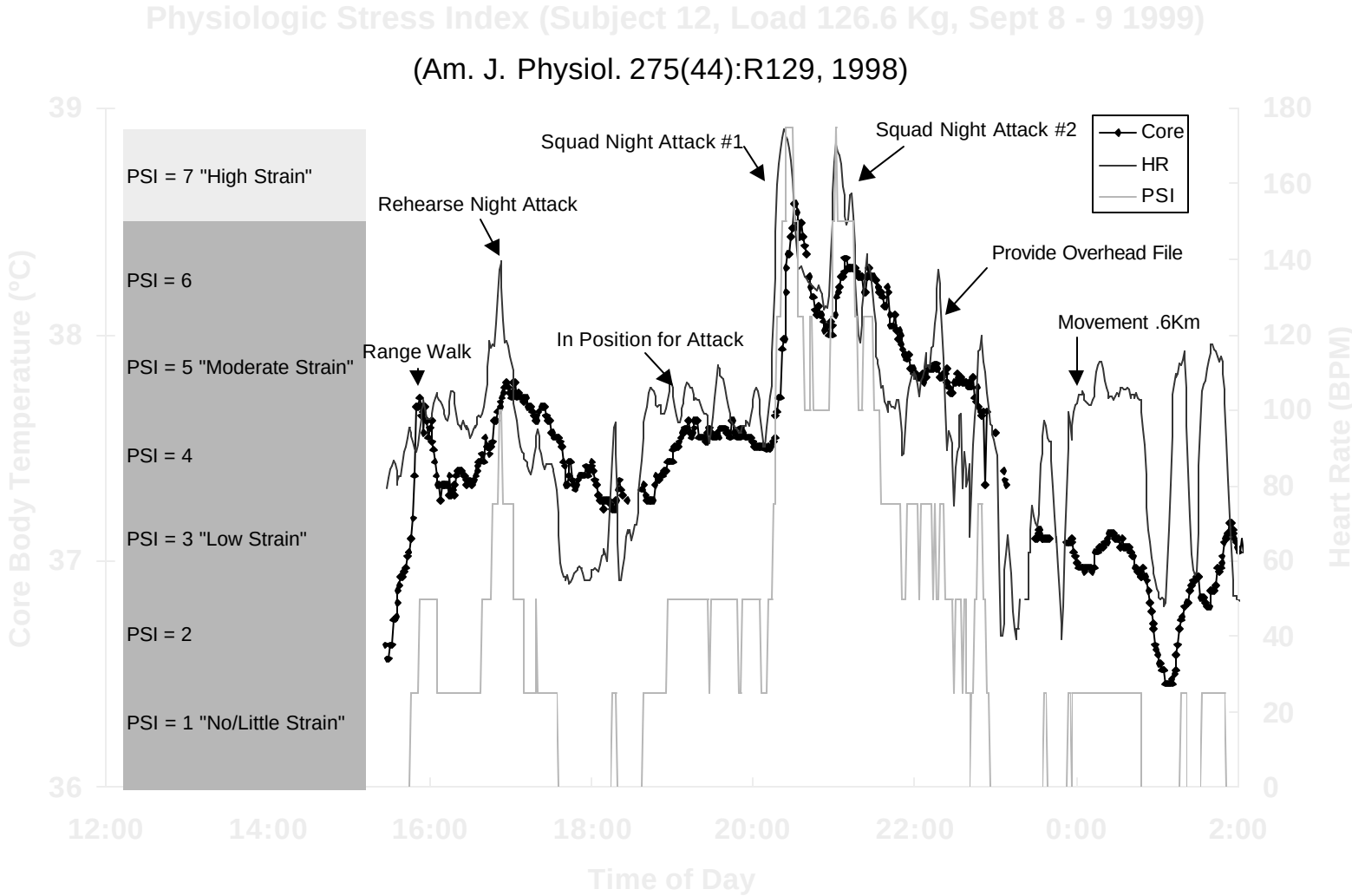


## Editor's Choice
high-resolution display panel

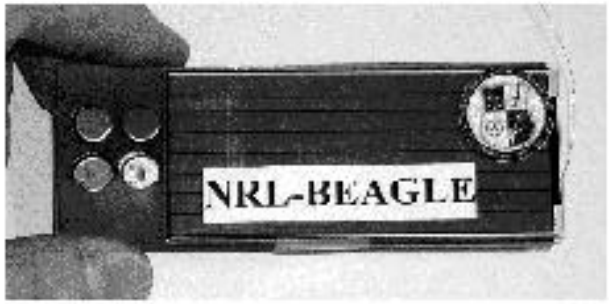
## Medical Products
motors & drives

# Warfighter Physiological Status Monitoring

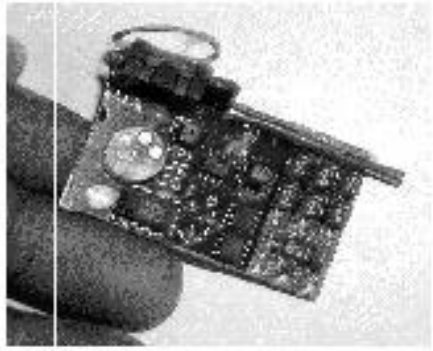
# Marine Data - September 1999



# Prototype NRL Chemical Agent Detectors

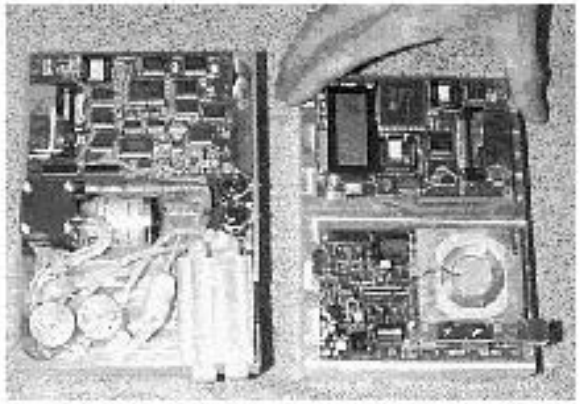



**"Badge Dosimeter" Format**



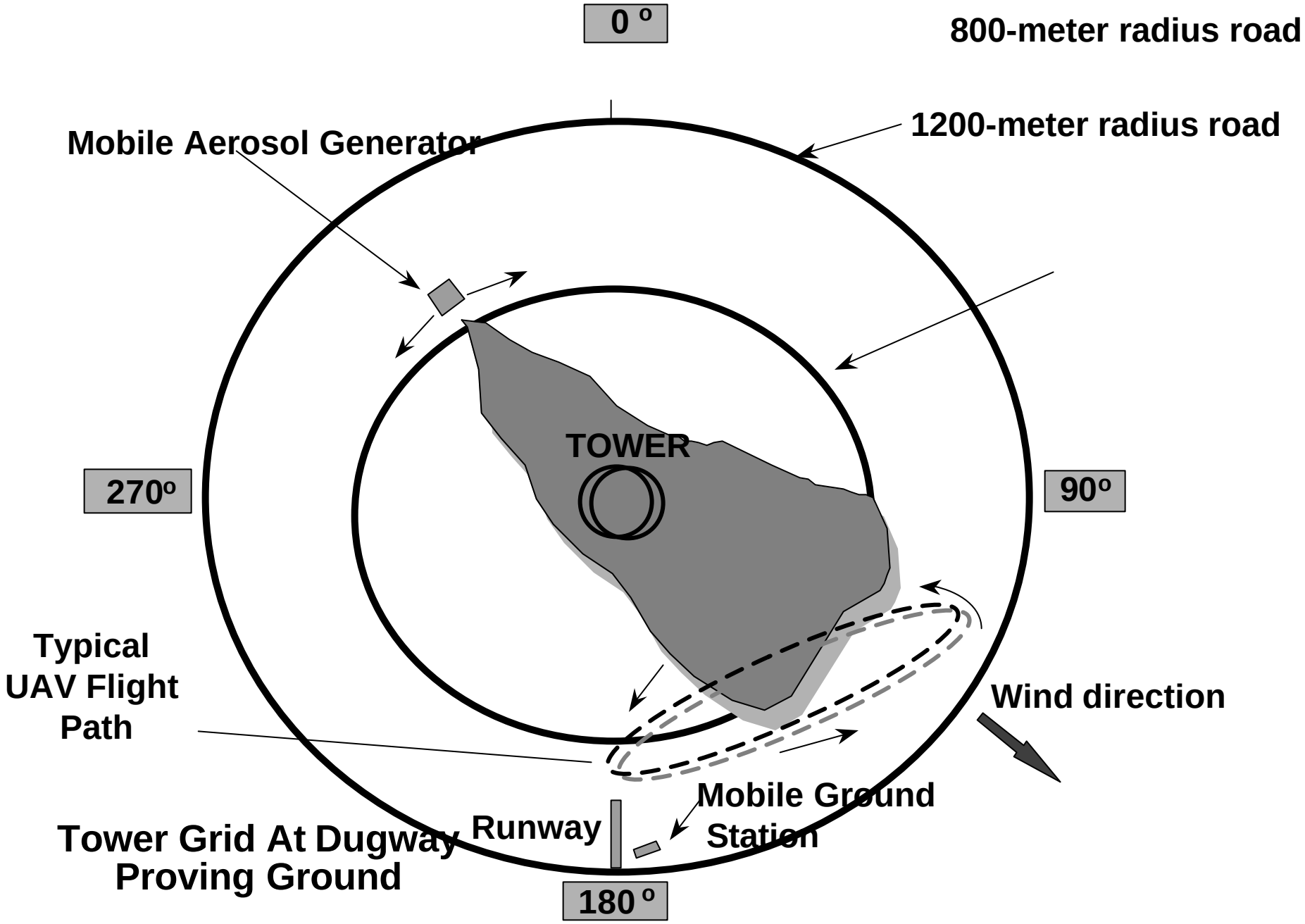
**NRL-BEAGLETTE**
**"Toss-&-Seek Applications"**

**NRL-CANARY II**
**UAV/Ground Applications**

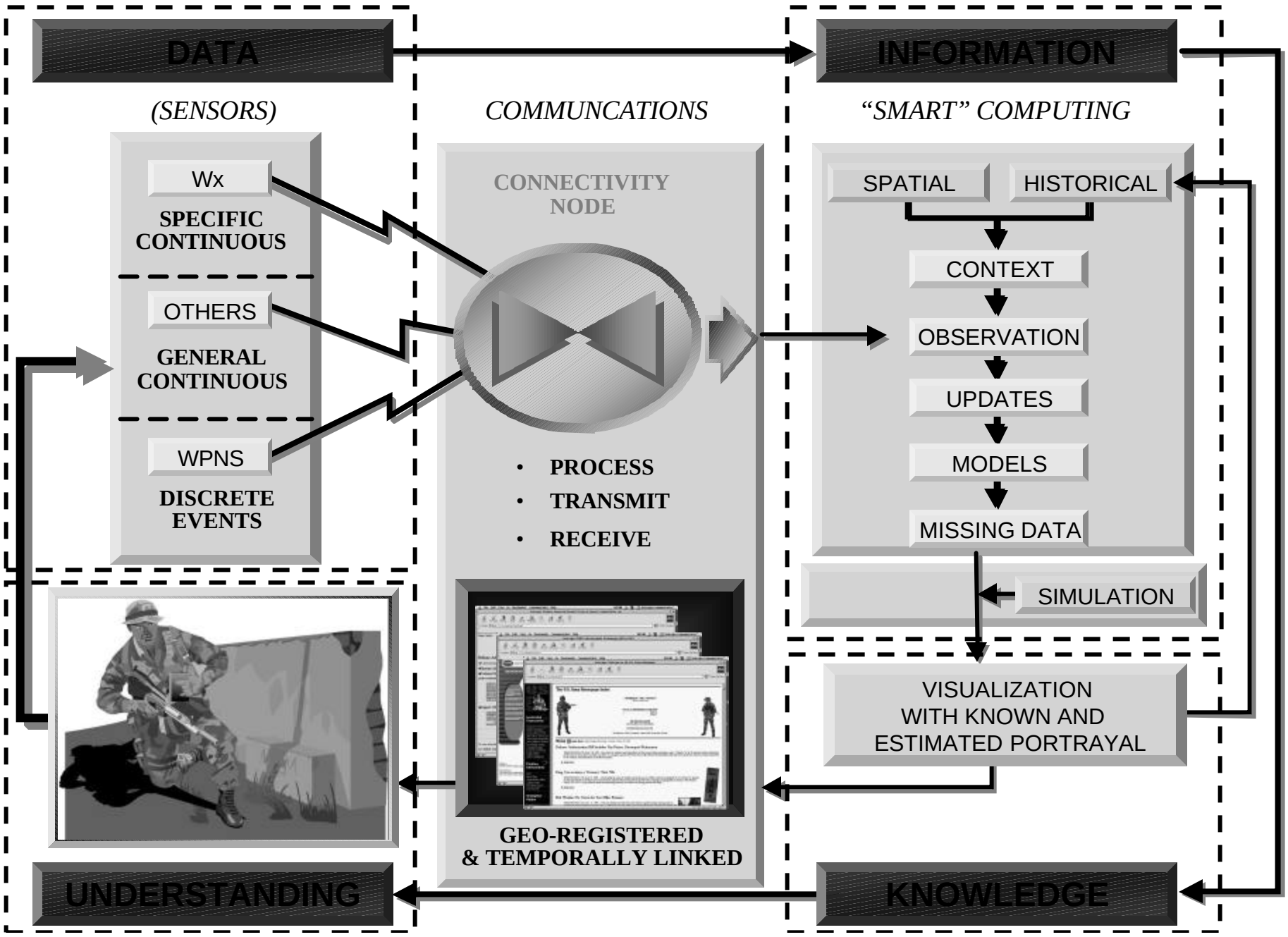


**ISCAD (IMS-SAW CAD)**
**Binary Detector/UAV Compatible**
**Ultra Low False Alarm**

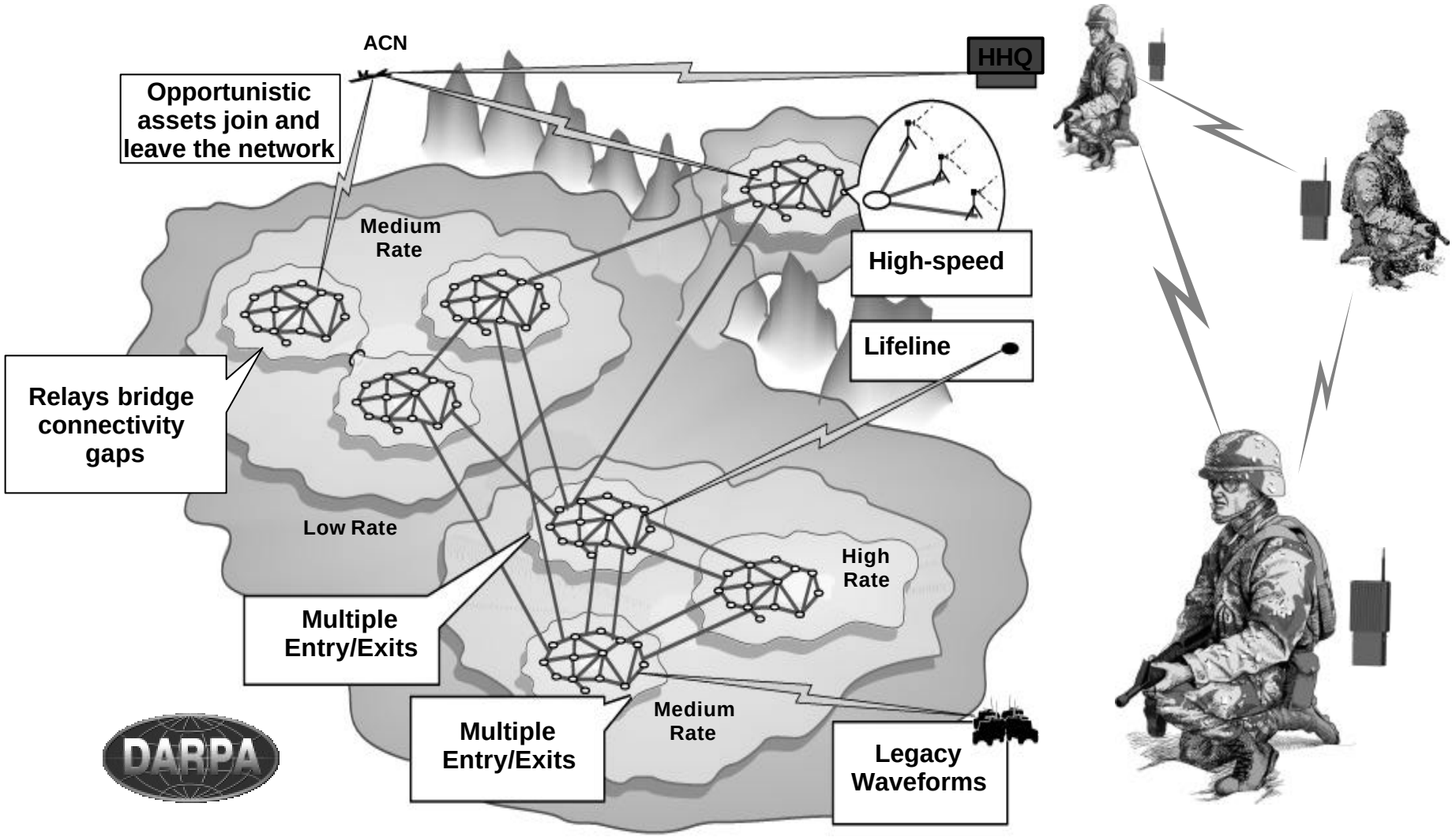
P.O.C: R. Andrew McGill
NRL MS&T Division, Code 6375
Tel: 202-767-0063
Email: amcgill@ccf.nrl.navy.mil


0 º
800-meter radius road
1200-meter radius road
Mobile Aerosol Generator
TOWER
270º
90º
Typical
UAV Flight
Path
Wind direction
Mobile Ground
Station
Runway
Tower Grid At Dugway
Proving Ground
180 º

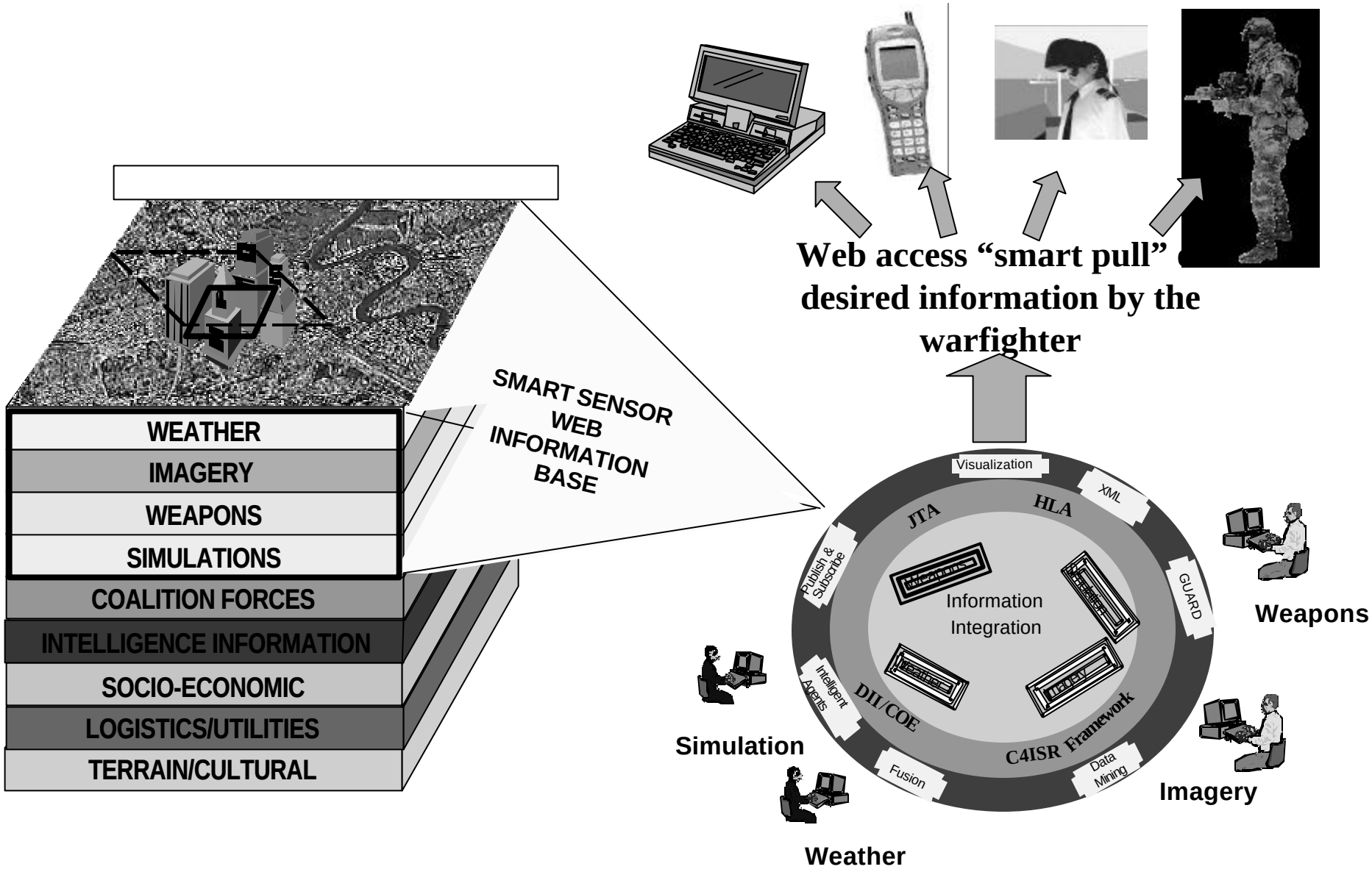
# Model of Smart SensorWeb



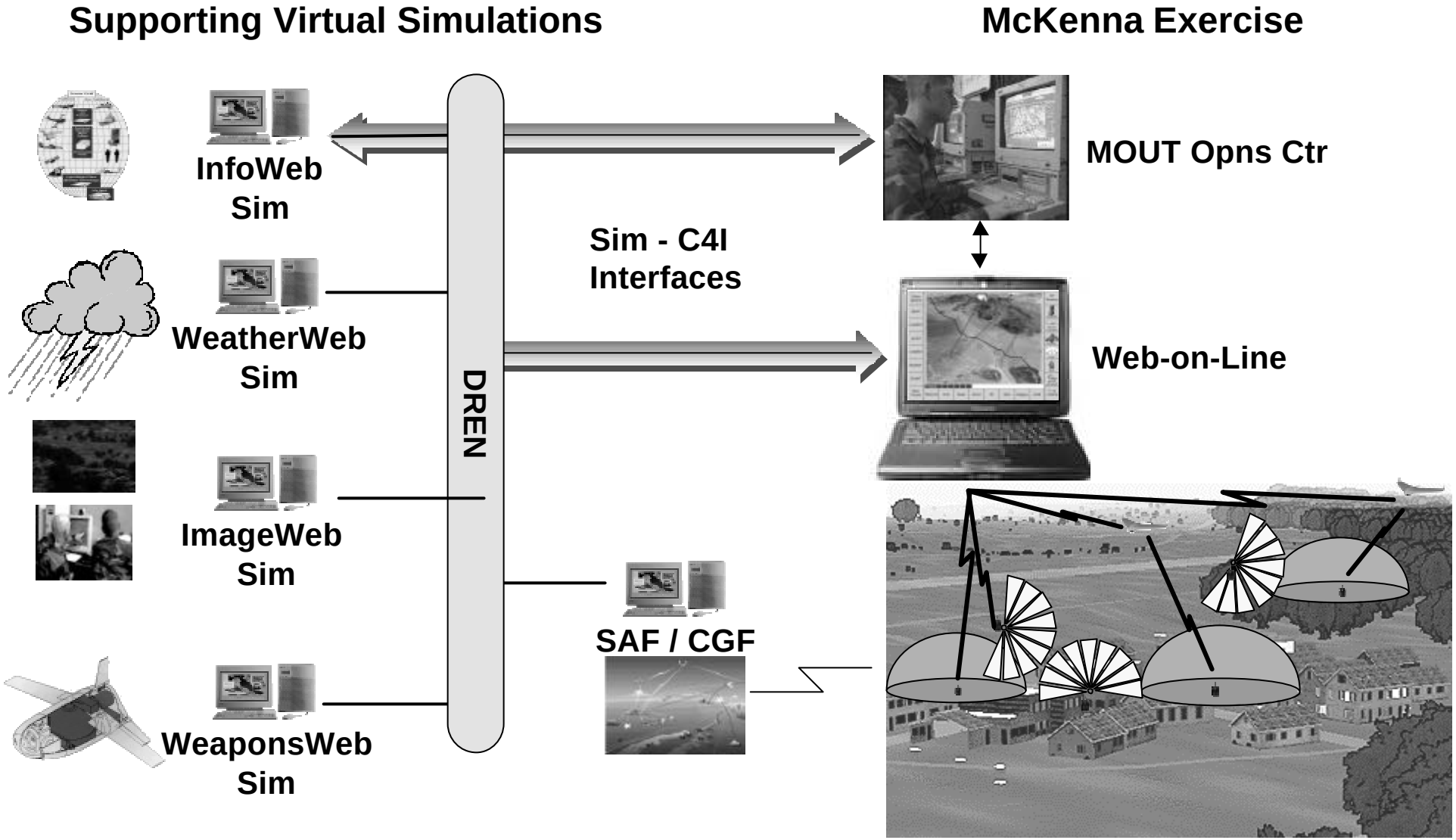
# SUO-SAS


ACN
HHQ
Opportunistic assets join and leave the network
Medium Rate
High-speed
Lifeline
Relays bridge connectivity gaps
Low Rate
High Rate
Multiple Entry/Exits
Multiple Entry/Exits
Medium Rate
Legacy Waveforms
DARPA

# Integrated Information Concept



# SSW Simulation Testbed Integration Concept



# *SOF UAV's*

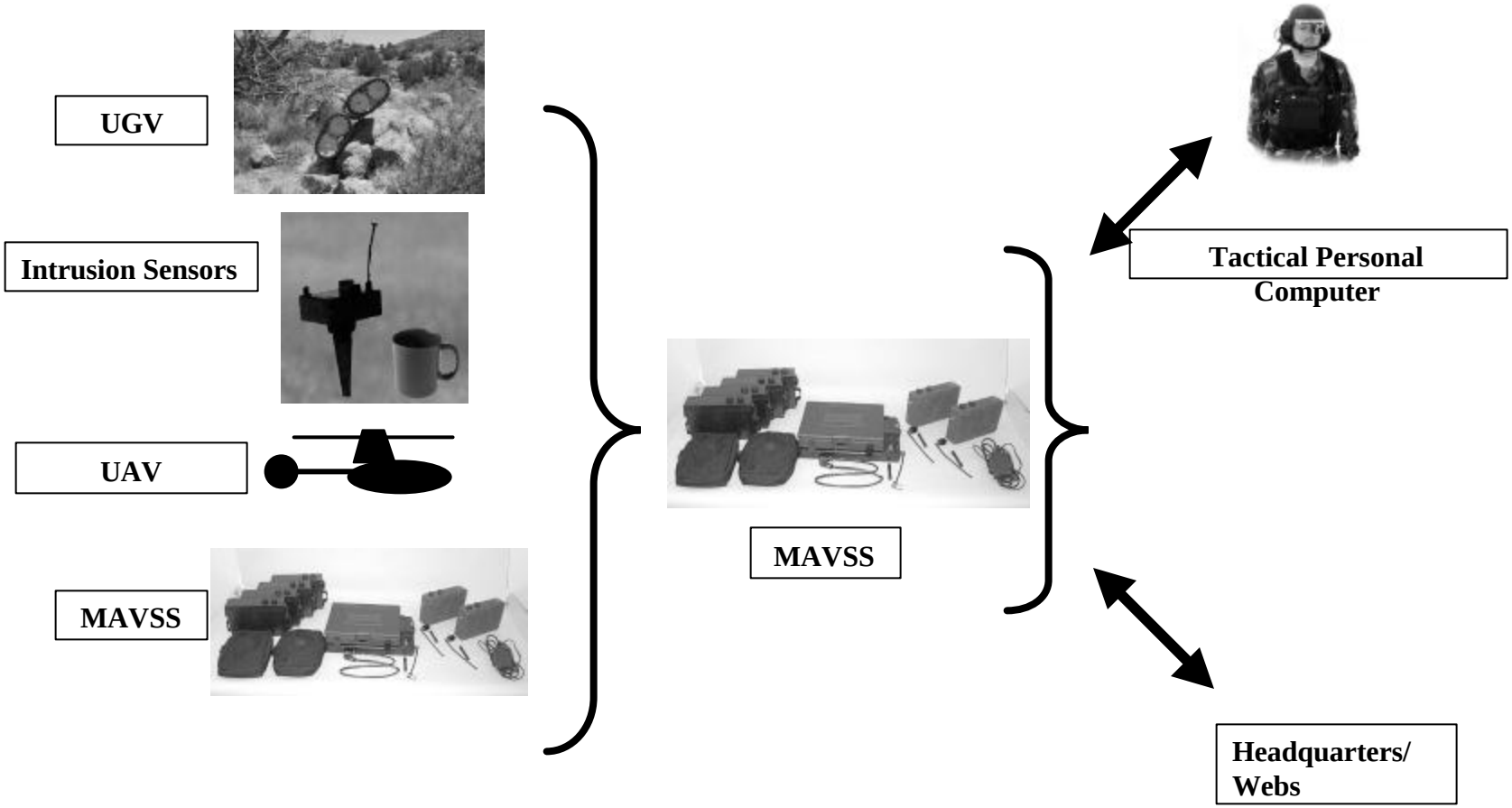
Maverick

Pointer

UF MAV

# *SOF Web*

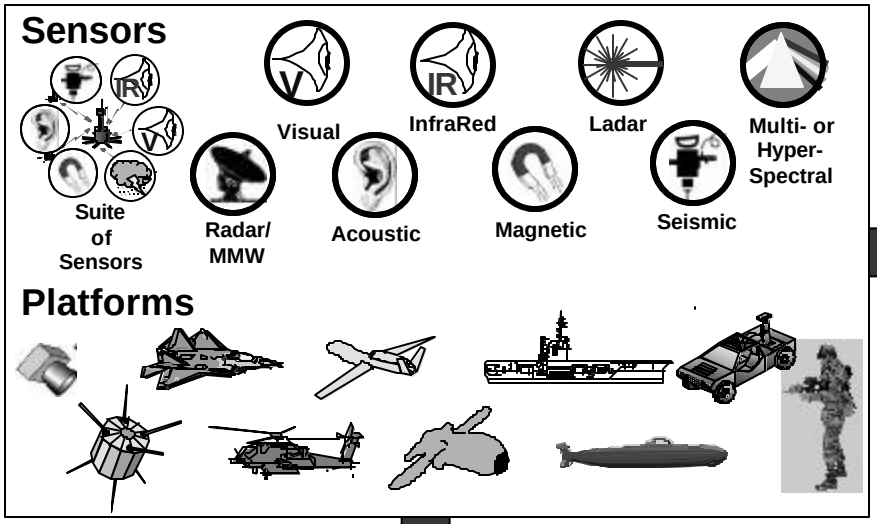
Sensors/ Platforms  Collection/Processing  Users



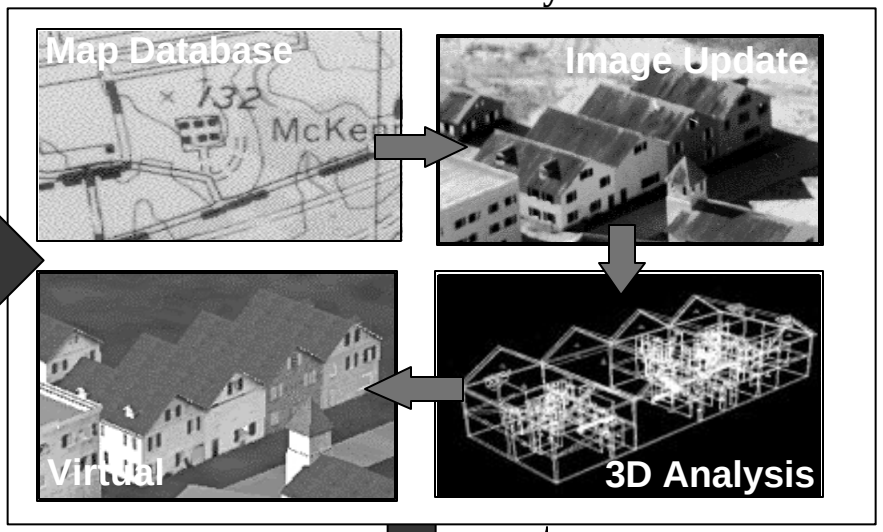

# *Base SSW Concept*

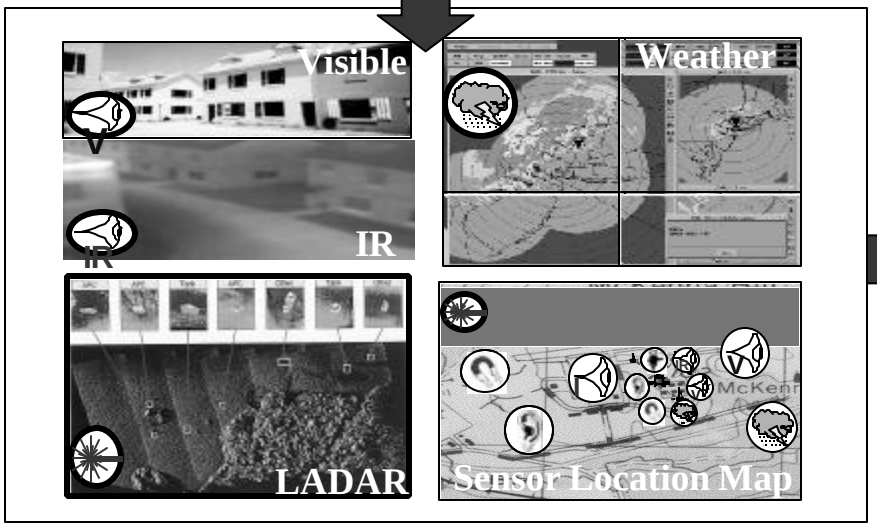
# Smart SensorWeb

**- Collection -**
**Sensors & Platforms**

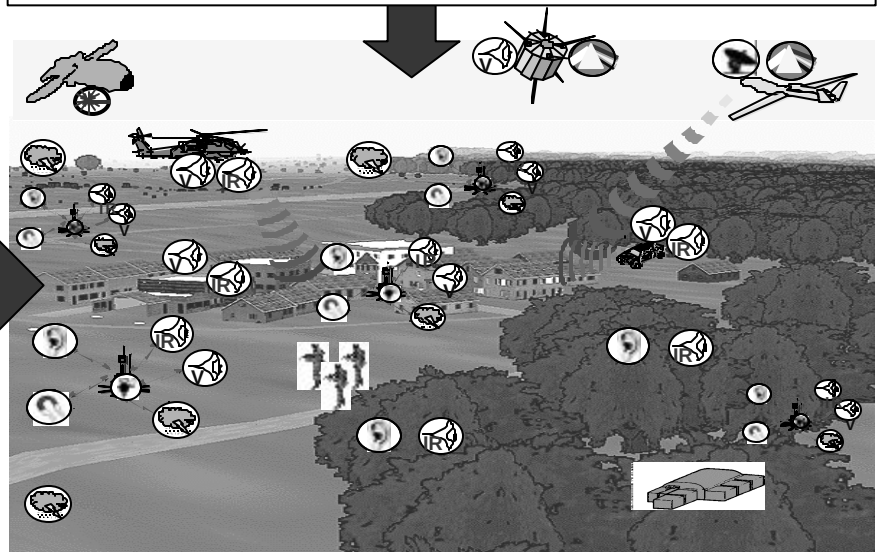



**- Computation -**
**Retrieval & Analysis**




**Display & Visualization**
**- Connotation -**



**Integrated, Continuous, Local, Sensor Collection**
**- Concept -**

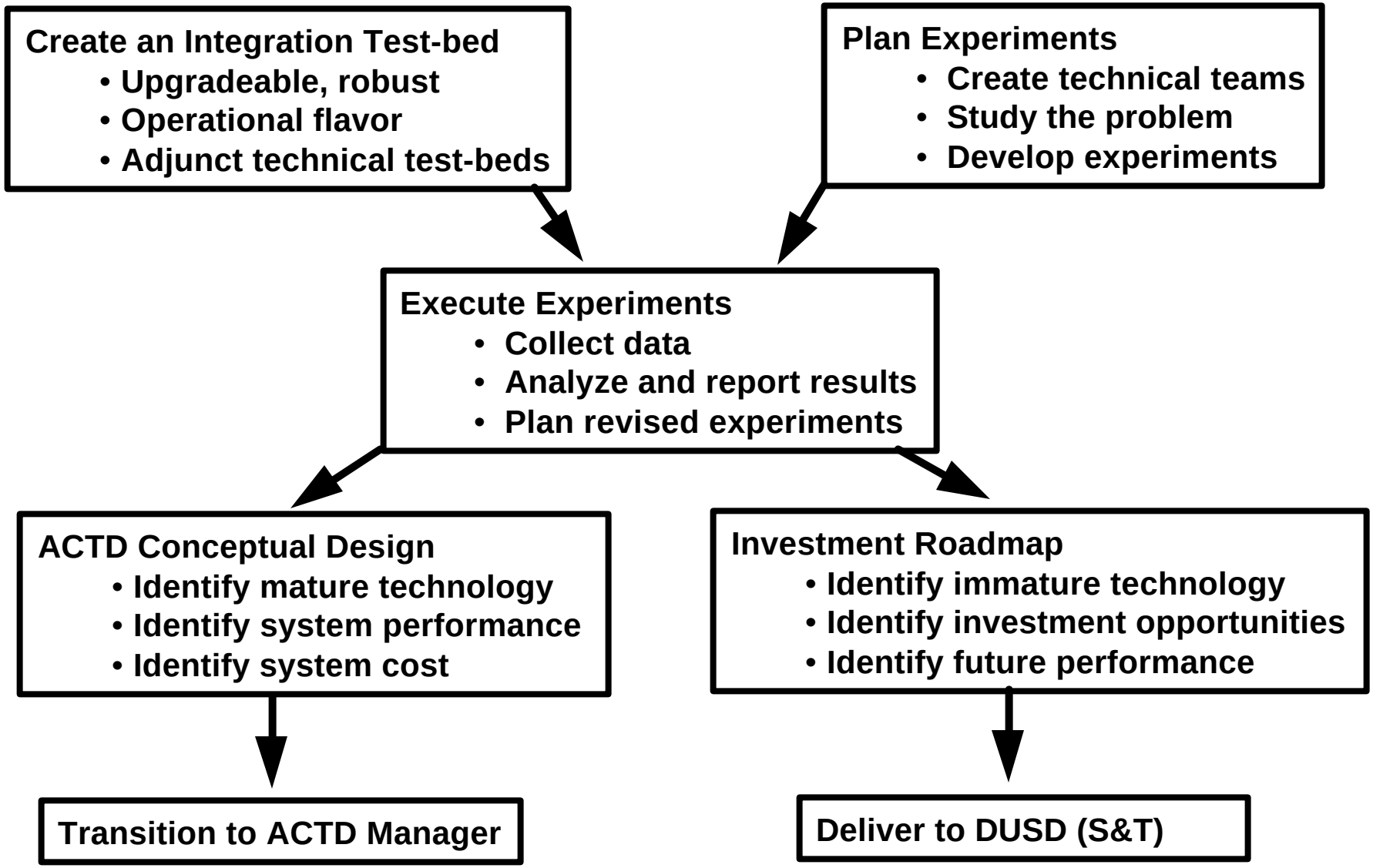
# Notional Objective System

| Echelon | Sensors | Communications | Database & Processing | Information Visualization |
|---|---|---|---|---|
| **Individual Soldier** | • Ported Wireless Visible & IR camera | • Body WLAN<br>• Throat to Text Commo | • Local video compression | • Earphone<br>• Miniaturized /eye-mounted display |
| **Fire Team** | • Toss able Local wireless visible and IR cameras | • Local Low-Medium bandwidth data link | • Local video Compression & force disposition<br>• VSAM | • Personal display |
| **Squad** | • Emplace able mid-range wireless video & acoustic sensors | • Local Medium bandwidth data link | • Local video compression & force disposition<br>• VSAM | • Personal Display |
| **Platoon** | • UGV & Emplace able long-range video & acoustic sensors | • Medium-High bandwidth data link | • Local video compression , force disposition & status update<br>• VSAM | • Personal Display |
| **Company** | • UAV & UGV | • High bandwidth data Link | • Local video compression & multi-sensor fusion<br>• VSAM | • Mobile TOC |
| **Battalion** | • Multiple UAV & UGV<br>• Displaced Acoustics | • High bandwidth data Link | • Local & external Information Fusion<br>• VSAM | • Fixed TOC |

**Additional Sensor Functions**

- **ChemBio**
- **Physio-Med**
- **Logistics/Maint**
- **Commo**
- **Location**
- **Weather**
- **Weapons**
- **Others**

# Program Execution



# Experiment Plan

## The System Driver

**Experiment # 1**

Value of the Information Products

Assess each product:

- Very useful
- Useful
- Somewhat useful
- Not useful

## The Functional Components

**Experiment # 2**

Information Architecture

- Assess needed bandwidth
- Assess various protocol

**Experiment # 3**

Sensors

- Assess power constraints
- Assess low cost sensors

**Experiment # 4**

Data Processing

- Assess ATRs, distributive processing
- Assess collaborative sensors
- Sensor/information fusion

**Experiment # 5**

Information Visualizations

- Assess product usefulness as function of interface
- Demonstrate simulation/live sensor fusion

## Key Integrated System Issues *(Optional)*

***Experiment # 6***

Mobility

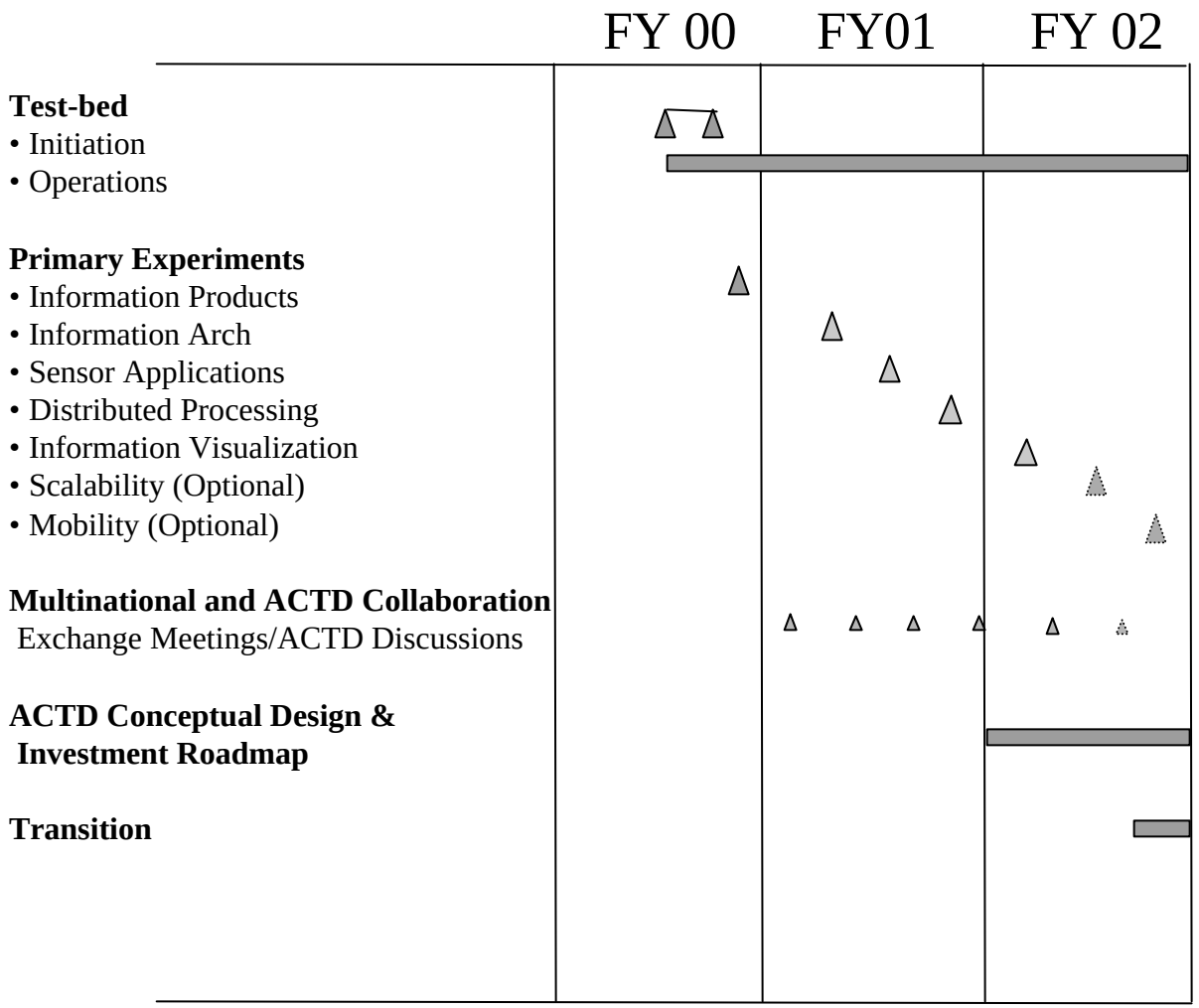
- Assess capability to enter unprepared terrain
- Demonstrate ability to rapidly simulate unprepared area

***Experiment # 7***

Scalability

- Assess issues associated with full battalion operations
- Demonstrate high resolution large battalion simulation

# Revised Program Schedule



# SSW Participants

- Army
  - ARL,
  - ARIEM,
  - TMDE,
  - TEC,
  - NVESD,
  - CECOM,
  - ARO,
  - Dismounted Battlespace Battlelab
- Air Force
  - AFRL/Eglin
  - AFRL/Rome
- Navy
  - NRL,
  - ONR,
  - SPAWAR,
  - OPNAV,
  - NAWCWD
- USMC
  - MCWL
- FFRDC
  - Lincoln Labs,
  - IDA,
  - SEI
- SOCOM
  - OST
- DARPA
  - SUO-SAS
  - SensIT
  - VSAM
- DMSO
- DTRA
- Industry
  - Casio
  - Sony
  - McQ

International: Germany, Sweden, England, Canada, & Australia

Next meeting 24-26 October, Lake Constance, Germany

# Leveraged Efforts

## Program Elements and Project Codes

**ImageWeb**
- **Army WEBS**
- **Army APLA**
- **Airborne Sensor Platforms**

**WeatherWeb**
- **Atmospheric Investigations**
- **Battlefield Environment & Signature Research**
- **University Partnering for Operations [Ar & AF]**

**WeaponsWeb**
- **Powered LOCAAS ATD**
- **Cruise Missile Real-Time Retargeting**

**SimulationWeb**
- **Integrated Sensor Modeling and Simulation**
- **Antipersonnel Landmine Alternatives**
- **Joint Countermine ACTD Simulation**

**Inormation IntegrationWeb**
- **Consistent Battlespace Picture**
- **Joint Battlespace Infoshpere**
- **METOC Architecture Study**
- **Dynamic Database**
- **General Intelligence Processor**
- **High Performance Computing**
- **Global Awareness Virtual Testbed**
- **JCS/J6V Multi-National Engineering Effort**
- **SUO/SAS**

## Technology Transfer Mechanisms

**MURIs**
- **13Projects**

**SBIRS**
- **10 Subjects: 6+ Proposals Each**

**APBI: Commercial Solicitation**
- **24 Companies**
- **47 Proposals**
- **10 Further Reviewed**
- **5 Funded**

## Involvement in Ongoing ACTDs

- **Military Operations in Urban Terrain**
- **Personnel Recovery**
- **Pathfinder**
- **CEASAR (Potential)**

## DARPA Programs

- **SUO-SAS**
- **SenseIT**
- **VSAM**

# ACTDs

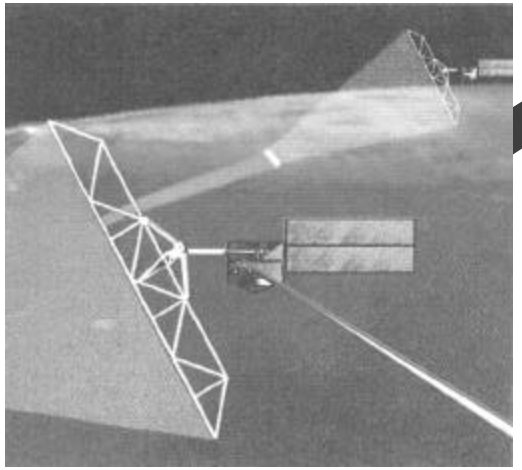
- Involvement in Ongoing ACTDs
  - Military Operations in Urban Terrain
  - Personnel Recovery
  - Pathfinder
  - CEASAR (Potential)
- SSW Working Group
  - ACTD Staff
  - Services
  - JFCOM, SOCOM
  - SSW Staff
- Possible Outcomes
  - Stand-alone ACTD
  - Multiple ACTD efforts
  - Support existing ACTDs
  - ATD

# DoD S&T is a Partnership

**Stable, Long Term Investment**

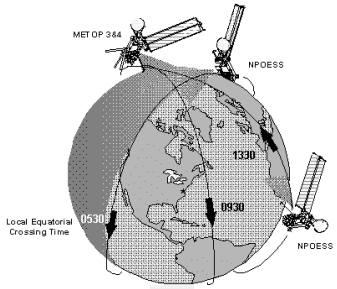
***Service Labs***

***DARPA***



**High Risk, High Payoff**

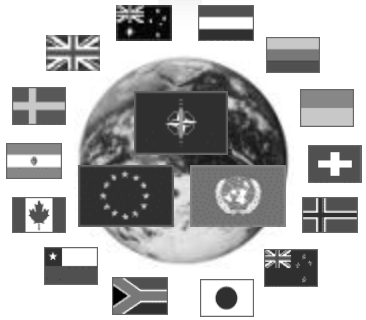
**Expanded Resource Base**




***Interagency***

**Maximum National Security Payoff**

***International***



**Coalition Capability**

**New Ideas, Knowledge**

***Universities***

***Industries***

**Innovation, Transition**

*Technical Superiority is Critical for National Security.*

*In peace, it provides deterrence;*
*In crisis, it provides options;*
*In war, it provides an edge.*